Determining the Importance of Shallow-Water Habitat in the Delta to Resident and Migratory Fishes: A New Challenge for IEP

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New challenges face investigators studying resident and migratory fish use of restored or newly created shallow-water habitats in the delta. Historically, most studies of fishes in this estuary have emphasized deep mid-channel and open-water areas. Sampling fish in shallow-water habitats presents many additional challenges due to increased habitat complexity, physical constraints to deploying sampling gear and access limitations. More importantly, with the exception of a few studies (e.g., Tidal Marsh Survey, K. Hieb pers. comm.; Yolo Bypass, T. Sommer pers. comm.), appropriate sampling methods are not fully developed for studying fishes in shallow-water habitats in this estuary. As a result, we currently have an incomplete understanding of the role of shallow-water habitat for fish (species and life stages) occupying these areas in the delta. In this article, we present our research approach and methodology for sampling fish in certain shallow-water habitats within the delta.

Since April 1998, DWR staff has been sampling shallow-water areas in the central delta as part of the Sacramento/San Joaquin Delta Breached Levee Wetland Study ("BREACH" for short) funded by CALFED Category III and IEP and coordinated by Charles Simenstad from the University of Washington. The BREACH study is an interdisciplinary research project investigating the patterns and rates of shallow-water habitat restoration within the delta and the ecological benefits provided at different stages of restoration. Results from this project will provide critical information necessary to predict whether breached-levee restoration strategies currently contemplated in the CALFED planning process will yield the expected ecosystem benefits to aquatic resources dependent on the delta. Furthermore, this study is expected to provide information useful to restoration projects currently in progress on Prospect and Decker islands. More information about the BREACH study is available on the WWW site " http://weber.u.washington.edu/~calfed/calfed.htm."

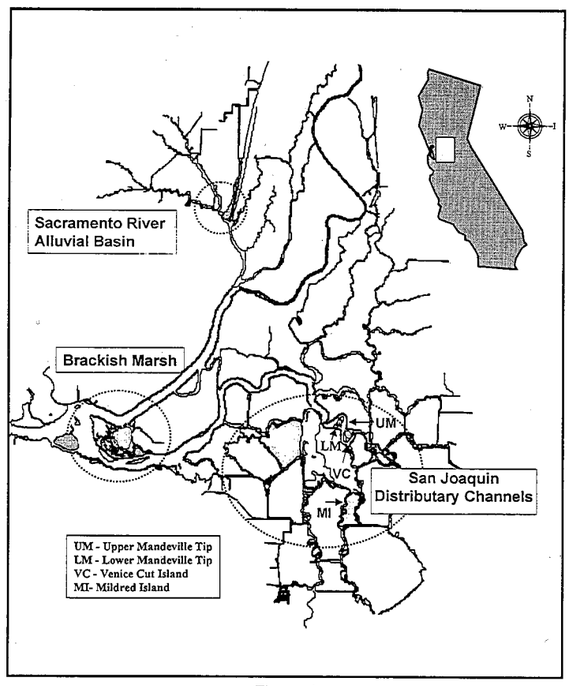

Figure 1
The Sacramento-San Joaquin Estuary study regions and site locations. Fish are only sampled in the San Joaquin Distributary Channel region.

Components of the full study include wetland sediment dynamics and geomorphology, vegetation, fishes, invertebrates (benthos, epibenthos and zooplankton), predator (fish)-prey linkages, and exotic species interactions. The objective of the fishes study element is to assess the potential for wetland restoration in the delta to provide essential functions and beneficial fish habitat. In order to meet this objective, we are comparing fish use in various habitats occurring within breached-levee restoration sites to natural (reference) marsh sites. Through this study we will attempt to answer the following questions:

- Does the fish assemblage within a habitat type vary between restored sites and the reference site?
- Does the fish assemblage (species type and abundance) vary with habitat type?
- What factors (e.g., time of day, habitat type, salinity, food availability, season, etc.) appear to be responsible for detected variations in the shallow-water fish community?

Study Sites

Study sites occur in three hydrogeomorphic regions of the delta categorized as Sacramento River Alluvial Basin (north delta), Brackish Marsh (western delta), and San Joaquin Distributary Channels (central delta) (Atwater 1980). Due to logistical constraints and to ensure adequate sampling effort based on the expectation of high variability, the fish sampling element is only being conducted in the central delta (Figure 1). The fish element study sites include one reference site (Upper Mandeville Tip) and three breached-levee restoration sites (Lower Mandeville Tip Island, inundated 66 years; Venice Cut Island, inundated 66 years; and Mildred Island, inundated 14 years). In addition, Venice Cut has also been the site of dredge material disposal, deposited approximately 14 years ago, which provides an opportunity to examine the response of such restoration "supplementation" strategies.

Sample Methodology

The term "shallow-water habitat" is misleading because it visually describes a monotypic environment with water depth as the limiting factor for fish use. Ground-truthing and initial investigations indicate that shallow-water habitats do vary and are characterized by many physical, chemical and biological attributes. It is highly likely these attributes can either limit or promote fish use (Zedler et al. 1997). Our research strategy is, to the extent possible, to examine or investigate the attributes (e.g., submergent and emergent vegetation, substrate type, tidal cycle, time of day, season, etc.) which are correlated with fish use. This study does not focus on target fish (i.e., chinook salmon or delta smelt). Rather the goal is to characterize the fish community and understand the attributes within the study sites that influence this community.

One of the more difficult tasks for this study was selecting gear types that would effectively collect fishes at all sites and shallow-water habitat types. Our initial pilot work and literature search (see Allen et al. 1992; Rozas et al. 1997) led to the selection of the following gear types: (1) block-net enclosure with depletion beach seining, (2) purse seines, (3) plankton nets, (4) light traps. An overview of targeted life stages, sample frequency and habitat types sampled for each gear type is presented in Table 1. Our methods for each gear type are summarized below.

Block-net enclosure with beach seine depletion. Enclosure samples are recommended for estimating densities of small fishes because they have high catch efficiencies and provide quantitative data (Rozas et al. 1997). Our enclosure technique for capturing small fishes is by depletion beach seine (7.6 m x 1.2 m, 3.2 mm mesh) sampling inside block-net enclosures (range 30-48 m^2) in vegetated and non-vegetated habitats 1.5 m deep. Perimeter stakes are set at least 24 hours in advance to minimize disturbance in the area. The following day(s) the area is enclosed with block nets. The enclosure is repeatedly swept with a beach seine to remove fish. At least four hauls in alternating directions are conducted until juvenile fish catch decreases for two consecutive hauls. Additional hauls are conducted in heavily vegetated habitats. Total fish species density within the enclosure is estimated by fitting a line or exponential decay function to the data for each haul. The advantage to using this sampling method is that it can be used to sample and characterize fish use in various habitat types and depths (up to 1.5 m) which are not traditionally sampled with beach seines.

Purse seines. Purse seines (30.4 m x 3.7 m, 3.2 mm mesh) are used to sample small fishes in interior open water and submergent vegetated habitats not accessible to wading (>1.5 m). The net is deployed off the bow, while the boat moves quickly in reverse in a tight circle. The ends of the net are joined together and then the lead line is "pursed" creating a closed bag. The net is lifted onto the boat and fish are removed for processing. A drawback to using this method is that the opening of the net can sometimes vary as a function of habitat type, current, wind and boat operator, so accurately determining the area sampled is difficult.

Plankton nets. To sample ichthyoplankton, we use a 50-cm diameter x 3.3-m long, 505 micron (stretched-mesh) plankton net that is mounted on an aluminum rod and towed off the side of the boat (running at 1,000 RPM) for ten minutes along inshore vegetated habitats and offshore non-vegetated habitats. A Clarke-Bumpas plankton net is mounted to the ichthyoplankton net frame to sample invertebrates concurrently during larval fish tows. This method allows us to sample larval fish in shallow-water habitats less than 2 meters deep, including emergent and submergent vegetation zones, as well as riprapped levees. By towing off to the side of the boat and manipulating the aluminum rod, we are able to maneuver the net immediately adjacent to or sometimes within or beneath emergent or floating vegetation. To our knowledge, we are the first to use this sampling method in shallow-water areas of the Delta.

Light traps. We use light traps at night to capture ichthyoplankton during 24-hour sampling series in vegetated and non-vegetated habitats in the flooded islands. This gear type is effective in slow moving shallow-water habitats of the Delta (A. Rockriver pers. comm.) The advantage to this gear type is the ability to sample densely vegetated areas where the plankton net cannot be towed.

Sample Frequency

Larval and juvenile fish are sampled twice per month from April through September during neap tides at each

of the fish sampling sites. Sampling will decrease to one neap tide per month October through December. To examine diel variation in juvenile and larval fish use among the flooded islands, seasonal 24-hour sampling series are scheduled at select sites. Our first 24-hour sampling event was completed in early June 1998.

Early Results

To date we have captured 27 fish species (8 native, 19 introduced). Our native fish catch includes fall-run and spring-run chinook salmon, delta smelt (larvae and adult), splittail (larvae and juvenile), tule perch, prickly sculpin, Sacramento sucker, Sacramento blackfish, and squawfish. High numbers of centrarchids (e.g., bluegill and redear sunfish) are captured at all sites each month. Young of the year (YOY) splittail and tule perch were abundant in May 1998. Currently, YOY yellowfin gobies and inland silversides are being collected in high numbers.

Literature Cited

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Table 1. Overview of Targeted Life Stages, Sample Frequency and Habitat Types Sampled for Each Gear Type

Gear Type	Targeted Lifestage	Sites/Locations	Frequency and Season	Water Depth *(in meters)*	Tidal Cycle	Habitat Types *(not inclusive)*
Block-net Enclosure	Small and juvenile fishes	All sites/inshore and small channels	Each site is sampled twice a month March–Sept., once a month Oct.–Dec.	< 1.5	Majority of sampling conducted around low slack	Submergent, emergent and floating aquatic vegetation and open water. Sand, mud, and woody debris substrates
Purse Seine	Small and juvenile fishes	All sites/inshore —offshore and wide channels	Each site is sampled twice a month March–Sept., once a month Oct.–Dec.	0-3	All tide cycles	Submergent, emergent and floating aquatic vegetation and open water
Plankton Net	Egg and larval fishes	All sites/inshore —offshore and channels	Each site is sampled twice a month Jan.–June	0-3	All tide cycles	Submergent, emergent and floating aquatic vegetation and open water
Light Traps	Larval fishes	All sites/inshore —offshore and channels	Designated site is sampled seasonally during 24-hour series	0.5-3	All tide cycles	Submergent, emergent and floating aquatic vegetation and open water

Migration and Wintering Areas of the Central Valley Swainson's Hawk

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Introduction

Subsequent to the 1994-95 Swainson's hawk(*Buteo swainsoini*) migration work and the discovery of mass poisonings of Swainson's hawks on La Pampas of Argentina (Woodbridge et al. 1995; Schmutz et al. 1996; Goldstein et al. 1996), the California-based Swainson's Hawk Technical Advisory Committee (TAC) initiated a migration study of the Central Valley population. Based on incidental observations and few band returns, the TAC surmised that the Central Valley hawks may be using alternative wintering grounds to those used by the main nesting population, and thus may be unprotected by efforts to reduce pesticide-induced mortalities in Argentina. The main nesting population (MNP) refers to Swainson's hawks in the geographically contiguous area that encompasses the Great Basin and Great Plains, and includes most nesting Swainson's hawks. The Central Valley population is currently estimated at 550-1,000 nesting pairs (CDFG 1988; Estep pers. comm.); the greatest concentration is in Yolo, Sacramento, Solano, and San Joaquin counties. The California Swainson's hawk population is approximately 10% of its 1800s population size (Bloom 1980); the species is listed as Threatened under the California Endangered Species Act.

Methods

In June and July 1997, TAC members attached 30-gram Platform Transmitter Terminals (satellite-tracked units) to six California Central Valley Swainson's hawks trapped at nest sites using a Dho-Gaza trap; four were trapped in Yolo County, one in Solano County, and one in San Joaquin County. Funding was provided by DWR. Due to weight constraints, no males were tagged. Tagged birds were tracked by NOAA satellites, and locational data were processed by Service Argos. Movements were plotted through the last week in December to determine migration routes and winter range.

From January 5 to 16, 1998, lead investigators traveled to Mexico to locate and confirm the wintering grounds of the Central Valley hawks. Three of the five delineated areas were visited. Observations were noted relative to numbers of Swainson's hawks using each area, land use practices, potential attractants to each area, potential prey items and foraging techniques, and potential threats to the species. Local experts were consulted relative to pesticide use, prey items likely to be found in the forage areas, and cropping patterns and other land use practices.

Results

On November 21, the southward progression of tagged birds from the Central Valley was lagging significantly behind the time line defined by the MNP Swainson's hawks that were tagged in 1994, 1995, 1996, as well as three MNP birds tagged and migrating concurrently with California birds in 1997. Data on tagged MNP birds indicate that Argentina-bound Swainson's hawks are across the equator by November 25, and in Argentina by December 25 (Woodbridge et al. 1995; Schmutz et al. 1996; Fuller pers. comm.). By December 25, southward migration of the Central Valley tagged birds had ceased, with all six birds displaying only local movements for a minimum of 30 days.

Five of the six tagged birds terminated their migration in Mexico; and one migrated to Columbia. The five birds that remained in Mexico traveled along the west coast of mainland Mexico to just south of Mazatlan. From that point, two birds went inland and southeast; one continued south through western Mexico until it settled at the border of Mexico and Guatemala. The sixth bird traveled laterally across northern Mexico, passing near Chuhuahua, to the gulf coast, then directly south to Central America. It crossed the Panama Canal within the same period that the MNP Swainson's hawks crossed, but stopped its migration at 1.5± degrees north of the equator in Columbia.

Of the five wintering areas identified through satellite tracking, three areas were surveyed for wintering Swainson's hawks, and described relative to habitat types and land uses. The three areas included the Santiago area, adjacent to Santiago Ixcuintla, just northwest of Tepic, in the State of Nayarit; La Barca, east of Guadalajara, in the States of Jalisco and Michoacan; and the Cuautla area, south of Mexico City, in the States of Morelos and Pueblo. Investigators were able to identify and observe a significant number of Swainson's hawks in each of the areas.

The Santiago area is on the coastal plain and includes extensive agricultural development, with hills and associated thorn forest adjacent to its eastern edge, and coastal wetlands bordering its western edge. Through observation and information provided by the State's agricultural authorities, investigators were able to determine that